pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20222115

Original Research Article

Study of changes in serum sodium and potassium levels in term and preterm neonates following phototherapy

Likitha Annachira Chinnappa*, Sudha Rudrappa

Department of Pediatrics, Mysore Medical College and Research Institute, Mysore, Karnataka, India

Received: 29 June 2022
Accepted: 30 July 2022

***Correspondence:**
Dr. Likitha Annachira Chinnappa,
E-mail: aclikitha@gmail.com

ABSTRACT

Background: Neonatal hyperbilirubinemia is a common physical finding in the first week of life. It is a common cause of hospital readmission during neonatal period. Phototherapy is an important treatment modality. However, it has some complications; amongst them serum electrolyte changes are a common complication. Objective of this study is to determine the changes in serum sodium and potassium in neonates before and after phototherapy and compare the occurrence of these changes in relation to gestational age and birth weight.

Methods: In a prospective hospital based comparative study both term and preterm neonates admitted in neonatal intensive care unit receiving phototherapy at Cheluvamba hospital Mysore from July 2021 to April 2022 (10 months) were studied. A predesigned proforma aided the enrolment of new-borns into the study. Serum bilirubin and electrolytes and a comparative study was made between before and after phototherapy groups to determine the incidence of electrolyte imbalance.

Results: The study group included 100 neonates. Incidence of low-birth-weight babies was 28% and preterm 22%. Mean birth weight and gestational age was 2.91±0.65 kg and 38.43±1.96 week respectively. The incidence of hyponatremia post phototherapy was found to be 9% which was more in low birth weight and preterm neonates ($p<0.001$) and was statistically significant. The incidence of potassium changes was found to be non-significant.

Conclusions: The study shows that neonates under phototherapy are at higher risk of hyponatremia. This risk is greater in premature and low birth weight babies and hence this group of babies should be closely monitored for electrolyte changes and managed accordingly.

Keywords: Electrolyte changes, Neonatal hyperbilirubinemia, Phototherapy

INTRODUCTION

Neonatal hyperbilirubinemia (NH) is one of the common morbidities in the newborn period during the first week of life. Most of the babies develop hyperbilirubinemia in early neonatal period.[1] The physical finding of yellowish discolouration of skin and sclera is due to accumulation of unconjugated bilirubin. It occurs due to immaturity of the liver's excretory pathway for bilirubin, when the bilirubin production is more in the initial days of life. Hence in most infants it reflects a normal physiological phenomenon. However, some babies may show significant rise in serum bilirubin and require treatment to avoid serious brain injury. NHnearly affects 60% of term and 80% of preterm neonates during first week of life.[2] Severe unconjugated hyperbilirubinemia if not managed appropriately is potentially neurotoxic as it can cause acute bilirubin encephalopathy and its sequelae. It is largely the frequent cause for newborns getting admitted again in primary days of living in current era of early postnatal discharge from hospital due to economical and social reasons.[3] Premature infants have neonatal jaundice at very elevated frequency which necessitate curative interference when compared to term neonates. Hyperbilirubinemia was found to be the most common morbidity (65%) among 137 extremely low birth weight neonates born over a period of 7 years in AIIMS.[4] High values of unconjugated bilirubin could proceed towards bilirubin encephalopathy and later kernicterus leading to permanent neurological development problems. Hence aptly managing NHis of supreme significance.[5] The key measure to prevent bilirubin encephalopathy in neonates include timely and effective treatment of marked hyperbilirubinemia. Hyperbilirubinemia can be treated either by phototherapy or exchange transfusion or pharmacologic agents. Phototherapy plays a significant role in prevention and treatment of hyperbilirubinemia. The main demonstrated value of phototherapy is that it reduces the need for exchange transfusion which is a potentially invasive procedure.[6] As any treatment has its side effects, phototherapy also have its adverse effects like hyperthermia, feed intolerance, loose stools, skin rashes, bronze baby syndrome, retinal changes, dehydration, hypocalcemia, redistribution of blood flow and genotoxicity. Unlike other side effects very few studies are currently available that depicts the adverse effects of phototherapy on serum electrolytes. Sodium, potassium and calcium are major electrolytes in the body and any deviation from normal levels in blood might cause neonatal convulsions, cardiac dysfunction, hemodynamic instability. Diarrhoea also being an adverse effect of phototherapy can also cause electrolyte disturbances.[7] Hypocalcemia is one of the known adverse effects. 90% of preterm and 75% of full-term neonates develop hypocalcemia after being subjected to phototherapy. Hypocalcemia can cause serious complication like irritability, jitteriness, convulsion, apnea. Hence phototherapy induced hypocalcemia is a significant problem.[8] Since there are only few studies available regarding the changes in the other electrolytes, this study is intended to determine the changes in electrolyte levels of serum sodium and potassium due to phototherapy in both term and preterm neonates.

METHODS

This study was a prospective hospital based comparative study conducted on eligible neonates which includes both term and preterm neonates admitted in the neonatal intensive care unit receiving phototherapy in Cheluvamba hospital, Mysore from October 2021 to May 2022 after ethical committee clearance.

Inclusion criteria

Neonates receiving phototherapy for unconjugated hyperbilirubinemia including exaggerated physiological jaundice isoimmune haemolytic anemia and without any co-morbidities like septicemia, birth asphyxia and renal failure.

Exclusion criteria

Neonates with conjugated hyperbilirubinemia, comorbidities like birth asphyxia, septicemia, renal failure, respiratory distress, major congenital anomalies, neonates with significant dehydration, abnormal electrolyte status detected before start of phototherapy, jaundice lasting more than 14 days, neonates requiring exchange transfusion were excluded from the study.

Procedure

The experimental protocol included written informed consent taken from parents after explaining the procedure in detail. Recording a detailed history as per the proforma which includes complete maternal history including maternal risk factors like hypertension, diabetes mellitus, oligohydramnios, anemia, fever, any rash or teratogenic drug intake. Complete head to toe examination of neonates. Icterus, skin changes, congenital anomalies and anthropometric measurements (weight, length, head circumference) were noted and documented. Blood investigations: venous blood samples were collected from the neonates included in the study and sent for estimation of total bilirubin, direct bilirubin, sodium and potassium along with blood grouping and typing. Total and direct bilirubin is measured by diazo method (diazotized sulfanilic test).

The principle of test

Bilirubin is changed to azobilirubin molecules when it is treated along diazotized sulfanilic acid otherwise called as Ehrlich’s Reagent. There is formation in acid of red purplish colour; strength within that colour is interpreted colorimetrically. Electrolytes (Na, K) measured by ST-100 auto analyser. Normal values of serum electrolytes: sodium: 135-145 mEq/l, potassium: 3.5-5.5 mEq/l and blood group of neonates was analyzed by antisera method. Serum sodium and potassium levels were checked at 0 hour before starting phototherapy (first sample) and at 48 hours of phototherapy or at discontinuation of phototherapy (second sample) whichever is earlier. The first samples were considered as controls. Comparative study was made between these two sample groups to determine the changes in electrolytes.

Statistical methods

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on mean±SD and results on categorical measurements are presented in N (%). Significance is assessed at 5% level of significance. The following assumptions on data is made: assumptions: dependent variables should be normally distributed, samples drawn from the population should be random, cases of the samples should be independent. Student t-test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters. Chi square test has been used to find the significance of study parameters on categorical scale between two or more groups, p<0.05 was considered statistically significant. The statistical software namely, SPSS for windows (version 20), was used for the analysis of the data and Microsoft word and excel have been used to generate graphs, tables.

RESULTS

The study group included 100 neonates. The study group consisted of 100 neonates. Incidence of males were 57% and females were 43%. Male:female ratio was 1.32:1. Incidence of preterm babies were 22% and term babies were 78%. Mean gestational age in the study group was 38.43±1.96.

Table 1: Sex of study group.

Sex	Male	Female	Total
N (%)	57 (57)	43 (43)	100 (100)

Incidence of low-birth-weight babies was 28%. Mean birth weight was 2.91±0.65. According to mode of delivery 65 were born by normal vaginal route while 35 were delivered by lower segment caesarean section.

Table 2: Gestational age of neonates.

Gestational age (weeks)	Gender, frequency (%)		Total (n=100)
	Male (n=60)	Female (n=40)	
<37	11 (18.3)	12 (30)	23
37-40	46 (76.6)	25 (62.5)	71
40	3 (5.1)	3 (7.5)	6

Table 3: Weight of neonates.

Weight (kg)	Gender, frequency (%)		Total (n=100)
	Male (n=60)	Female (n=40)	
<2.5	12 (21.05)	16 (39)	28
>2.5	45 (78.9)	27 (60.54)	72
Total	57 (100)	43 (100)	100

Table 4: Correlation of post phototherapy serum electrolytes with gestational age.

Serum electrolytes	Gestational age (weeks)			Total (n=100)
	<37 (n=23)	37-40 (n=71)	>40 (n=6)	
Sodium				
<135	7 (31.8)	2 (2.8)	0	9
135-145	15 (68.2)	69 (95.8)	4 (66.7)	88
>145	0	1 (1.40)	2 (33.33)	3
Potassium				
<3.5	0	1 (1.4)	0	1
3.5-5.5	21 (95.5)	70 (97.2)	5 (83.33)	96
>5.5	1 (4.5)	1 (1.4)	1 (16.7)	3

Table 5: Correlation of post phototherapy serum electrolytes with gestational age.

Pearson Chi square tests	Value	df	P value
Sodium	37.844	4	0.000
Potassium	5.035	4	0.284

Table 6: Correlation of post-phototherapy serum electrolytes with duration of phototherapy.

Serum electrolytes	Duration of phototherapy (hours)			Total (n=100)
	<24 (n=4)	24-48 (n=69)	>48 (n=27)	
Sodium				
<135	0	5 (5.5)	4 (80)	9
135-145	4 (100)	84 (92.3)	0	88
>145	0	2 (2.2)	1 (20)	3
Potassium				
<3.5	0	1 (1.1)	0	1
3.5-5.5	4 (100)	87 (95.65)	5 (100)	96
>5.5	0	3 (3.3)	0	3

Table 7: Correlation statistics of post-phototherapy serum electrolytes with duration of phototherapy.

Pearson Chi-square tests	Value	df	P value
Sodium	39.397	4	0.000
Potassium	0.412	4	0.981

Table 8: Conclusive comparative evaluation of study variables pre and post phototherapy in neonates.

Variables		Mean	N	SD	SEM
Pair 1	Pre total bilirubin	17.985	100	1.972	0.197
	Post total bilirubin	11.321	100	2.178	0.217
Pair 2	Pre sodium	139.84	100	2.372	0.237
	Post sodium	137.30	100	3.319	0.331
Pair 3	Pre potassium	4.609	100	0.565	0.056
	Post potassium	4.658	100	0.590	0.059

Table 9: Conclusive comparative statistics for evaluation of study variables pre and post phototherapy in neonates.

Paired samples test						
Variables		**Paired differences**		**T value**	**df**	**Significance (2-tailed)**
		Mean	**SD**			
Pair 1	Pre and post bilirubin	6.66	2.003	33.255	99	0.000
Pair 2	Pre and post sodium	2.54	3.099	3.099	99	0.000
Pair 3	Pre and post potassium	-0.049	0.344	0.344	99	0.158

In our study majority of the neonates were in the age group of 3-5 days. Mean duration of phototherapy was 36.74±10.1 hours. The Incidence of hyponatremia following phototherapy was also more in low-birth-weight babies (28.69%) than in normal babies (1.4%). Thus, it infers that low-birth-weight babies were at more risk of hyponatremia following phototherapy than term babies. By Pearson Chi square test using test for paired sample means, the p value obtained was <0.001, considered to be statistically significant. The incidence of potassium changes following phototherapy was found to be non-significant (p=0.806) in both low birth weight and normal babies. The incidence of hyponatremia following phototherapy was more in preterm neonates (31.8%) than in term neonates (2.8%). Thus, it infers that preterm baby were at more risk of hyponatremia following phototherapy than term babies. By Chi square test, using test for paired sample means, the p value obtained was 0.000, which was considered to be statistically significant. Incidence of potassium changes following phototherapy was found to be non-significant (p=0.284) in both term and preterm babies. The Incidence of hyponatremia was 80% when duration of phototherapy was >48 hrs as compared to duration <48 hrs (5.5%). Thus, it infers those babies were at higher risk of hyponatremia if kept under phototherapy for more than 48hrs. By Chi square test, using test for paired sample means, the p value obtained was 0.000, which was considered to be statistically significant. Changes in total bilirubin, sodium and potassium levels before and after phototherapy are shown in Table 7. Even though none of the neonates in present study developed signs of hyponatremia sodium changes were significant in babies after 48 hours of phototherapy. The p value obtained was <0.01 and thus considered statistically significant. The incidence of hyponatremia was found to be more in preterm and low birth weight babies when compared to term and normal birth weight neonates.

DISCUSSION

NH is one of the common causes for neonatal morbidity during the first week of life. Early discharge of healthy term newborns from the hospital after delivery has recently become a common practice for medical, social and economic reasons. Neonates who have a post-delivery hospital stay below 72 hours are at a considerably greater risk for readmissions compared to the neonates those whose stay is above 72 hours. There is of concern due to reports of bilirubin induced brain damage resulting in sequelae like kernicterus as a result of delay in initiation of treatment. The need for early detection of hyperbilirubinemia in the early discharged newborns from the hospital is therefore important. Phototherapy has emerged as the most widely used form of treatment. In order to diminish the rigorousness of neonatal unconjugated hyperbilirubinemia this is the therapy of preference. As any treatment has its adverse effect phototherapy also has some side effects but they are not harmful or severe. One of the side effects includes electrolyte imbalances. A few studies in the recent past have stressed on the incidence of hypocalcemia following phototherapy and very few studies till date regarding the effect of phototherapy on electrolytes. Hyponatremia, a very common electrolyte abnormality, is a serum sodium level <135 mEq/l. Hyponatremia exists when the ratio of water to sodium is increased. This condition can occur with low, normal, or high levels of body sodium. Similarly, body water can be low, normal, or high.

Hypokalemia is defined as serum potassium level below 3.5 meq/l. Both electrolytes play a major role in various metabolic functions.

Hence our study was designed to determine the electrolyte changes of sodium and potassium in neonates receiving phototherapy. The present study included total of 100 neonates including both term and preterm.

Gozetici et al conducted a study which included only term neonates.[9] Mean gestational age of our study group preterm vs term were 35.86±1.3 weeks vs. 39.55±0.2 weeks respectively which was in correlation to Bezboruah et al study 34.22±1.15 weeks vs. 38.56±0.66 weeks respectively.[10]

Mean birth weight in our study was 2.2±3.2 kg in pre-terms vs 2.8±1.7 in term neonates. Mean total serum bilirubin in our study group were 16.15±1.62 in preterm vs. 17.65±1.82 in term neonates similar to study conducted by Subhashini et al 16.98±1.78 and 18.56±1.81 for preterm and term neonates respectively.[11] The study conducted by Gozetici et al included term neonates with a mean total serum bilirubin of 18.4±1.82. Mean duration of phototherapy in our study was 36.74±10.04 hours similar to the duration in the study conducted by Gayathri Bezboruah et al and Subhashini et al which is in contrast to the phototherapy duration used in the study by Uzzal et al of 72±17.78 hours.[12] The mean±SD of serum sodium in our study was 139.84±2.37 and 137.3±3.31 before and after phototherapy respectively.

Results analysed using paired t test shows statistically significant p value. Similar results were found in other studies which conclude phototherapy causes significant changes in serum sodium levels. Study by Bezboruah et al found a decline in mean serum potassium levels following phototherapy. However, no such association was found between serum potassium levels and phototherapy in our present study. Incidence of hyponatremia in our study group was 9 and found to be higher in <37 weeks group (31.8) and LBW group (28.69) compared to >37 weeks. (2.8) and normal weight babies (1.4). Mean serum sodium levels were significantly decreased after phototherapy as the p value obtained was 0.000. The incidence of hyponatremia was found to be increased with increasing duration of phototherapy beyond 48 hours. Our study did not show any significant changes in levels of serum potassium following phototherapy. Curtis MD et al studied diarrhoea in jaundiced neonates treated with phototherapy. Study showed that absorption of sodium, chloride and potassium was significantly impaired in the patients receiving phototherapy.[13] Beresford et al and Conolly et al stated that babies under phototherapy can have sodium imbalances due to insufficient fluid replacements.[14] In the present study a significant decline in serum sodium levels was found following phototherapy. As the new-borns with pathological weight loss were not included, the decrease in serum sodium levels may be attributed to phototherapy rather than existing hypernatremic dehydration. However, mechanism has not been clearly explained in any of the studies. Decrease in serum sodium levels after phototherapy could be due to reduced intestinal absorption because of diarrhoea which is another side effect of phototherapy. The exact cause for hyponatremia is still under debate.

Limitations

Limitations of current study were, it was evident that in the present study phototherapy induced sodium changes was more in preterm LBW babies as a result of immature renal functions. As preterm babies are prone for more metabolic derangements than term babies actual relationship in these babies with phototherapy has to be evaluated with larger sample studies.

CONCLUSION

Incidence of hyponatremia in our study group is 9 and is higher in preterm (31.8) and low birth weight babies (28.6) than in term (2.8) and normal weight babies (1.4). Incidence of hyponatremia following phototherapy is higher when duration of phototherapy is more than 48 hours when compared to less than 48 hours. No incidence of hyponatremia when duration is less than 24 hours. Mean serum sodium levels significantly decreased after phototherapy. Hence serum electrolytes should be checked periodically in newborn babies receiving phototherapy to detect electrolyte imbalances. Preterm and low birth weight babies are at a higher risk for phototherapy induced electrolyte disturbances. Hence this group of babies should be closely monitored. Proper monitoring of electrolytes in neonates during phototherapy and by ensuring adequate breastfeeding and hydration dyselectrolytemia and its complications can be prevented.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Martin RJ, Fanaroff AA, Walsh MC. Fanaroff and Martin’s neonatal-perinatal medicine: Diseases of the fetus and infant. 11th ed. Philadelphia: Elsevier/Saunders; 2019;1788-96.
2. Maisels MJ. Jaundice. In: Avery GB, Fletcher MA, MacDonald MG, eds. Neonatology: pathophysiology and management of the newborn. 6th ed. Philadelphia: Lippincott Williams and Wilkins; 2005;765-820.
3. Maisels MJ, Kring E. Length of stay, jaundice, and hospital readmission. Pediatrics. 1998;101:995-8.
4. Narayana S, Aggarwal M, Upadhyay A, Deorari AK, Sindh M, Paul VK. Survival and morbidity in extremely low birth weight (ELBW) infants. Indian Pediatr. 2003;40(2):130.
5. Das S, Landeghem FKH. Clinicopathological spectrum of bilitubin encephalopathy/kernicterus. Diagnostics. 2019;9:24.
6. Slusher TM, Zamora TG, Appiah D, Stanke JU, Strand MA, Lee BW, et al. Burden of severe

neonatal jaundice: A systematic review and meta-analysis. Br Med J Paediatr. 2017;1:e000105.
7. Dutta S. Phototherapy for neonatal jaundice recent advances and controversies. J Neonatal. 2001;1(1):39-44.
8. Karamifar H, Pishva N, Amirhakimi GH. Prevalence of phototherapy induced hypocalcemia. Iran J Med Sci. 2002;27(4):166-8.
9. Gozetici MA, Yigit AK. Effect of phototherapy on serum electrolyte levels. Cerrahpasa Med J. 2018;45(1):16-20.
10. Rani MR, Santhalakshmi M, Saravanan L. Study on serum electrolyte changes in neonates receiving phototherapy for unconjugated hyperbilirubinemia. Indian J Clin Anat Physiol. 2018;5(1):22-55.
11. Reddy AT, Bai KV, Shankar SU. Electrolyte changes following phototherapy in neonatal hyperbilirube-nemia. Int J Sci Res. 2015;4(7):231-7.
12. Ghosh UK, Parvin R, Sultana A. Electrolyte changes following phototherapy in neonatal hyperbilirubi-nemia. Jahurul Islam Med J. 2020;15(1):130-5.
13. Curtis MD, Guandalini S, Fasano A, Ciccimarra F. Diarrhoea in jaundiced neonates treated with phototherapy: role of intestinal secretion. Arch Dis Child. 1989;64:1161-4.
14. Beresford D, Conolly G. Fluid and electrolyte balance. In: Neonatal intensive nursing care. 3rd ed. Washington DC: Routledge Taylor and Francis Group; 2015:258.

Cite this article as: Chinnappa LA, Rudrappa S. Study of changes in serum sodium and potassium levels in term and preterm neonates following phototherapy. Int J Contemp Pediatr 2022;9:793-8.